**Magnets, Electromagnets, and Neutrino Beams – LESSON PLAN**

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| **Lesson #6** | Practical Applications: Move it! |
| Overview  Standard(s)  & Objectives | **Overview:** In this lesson students will use the device from last session to further investigate magnetic forces  **Standards**:  3-PS2-2: Make observations and/or measurements of an object’s motion to provide evidence for how a pattern can be used to predict future motion.  (SEP:3, DCI: PS2.A; CCC: Patterns)  3-PS2-3: Ask questions about cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. (SEP: 1; DCI: PS2.B; CCC: Cause/Effect)  4-PS3-2 Make observations to provide evidence for how energy can be transferred from place to place by sound, light, heat, and electric currents. (SEP: 3; DCI: PS3.A, PS3.B; CCC: Energy/Matter)  **Objectives:** Students will use their straw compasses and assorted magnets to discover how magnets can be used to move other objects. |
| Background  Information | The device built previously is a compass that can be moved by using magnets to repel, attract, or in a combination of both. Magnets should have one pole marked to help with the inquiry process. |
| Materials | For Each:   * Science Notebook * Handouts: Design Your Experiment, Data Tables   For Each Pair or Small Group of 3-4:   * 1 straw compass made during previous session * 4 flexible magnets (25 x 20 x 5 mm) (1 x ¾ x 2/16 inches) with a 5mm hole in middle pre-marked so like poles are indicated with a red sticker.   Have on hand other items in case groups need them for their designed experiment:   * More flexible magnets * Other types of magnets with various strengths (ceramic magnets, rare earth magnets, etc.) * Stop watches or other time keeping devices (timers, etc) |
| Prior Knowledge | * Magnets can attract or repel based on their orientation. * The north pole of one magnet attracts the south pole of a second magnet, while the north pole of one magnet repels the other magnet's north pole.   Students will use this knowledge to move the compass by putting like poles near each other to activate repelling action, rotating as necessary when the other magnet comes around. Alternatively they will do the same with the force of attraction, focusing on having unlike poles pulling the magnets and rotating as necessary. |
| Launch (6 minutes) | |
| Engagement and CommunicateStudent Goals and  Expectations | State: Today you will use the device you built earlier to further investigate the power of magnets. But first, let’s see why we should care. What does this have to do with real life? You might be surprised. Watch this video about Maglev Trains. Pay special attention to how the two different types of trains work. How are they the same? How are they different?  <https://www.youtube.com/watch?v=aIwbrZ4knpg>  Now you will have a chance to explore. Remember to use magnets in a variety of ways to move the compass you created in different directions without touching it. After you’ve discovered some different ways you can move the compass, your task will be to devise an experiment in which you change one variable and collect data in a chart, table or graph. You will get a planning sheet to design your experiment after you’ve had some time to discover.  What might you choose to use as a variable? These are things to think about as you investigate just how magnets work together to create movement.  Goal:   Use magnets to move the device you created in different directions without touching it. After you have investigated how magnets interact with each other, you will design an experiment to demonstrate your learning. Remember to change only one variable. |
| Explore (Time: 40 minutes) | |
| Procedure | 1. Gather the necessary materials. 2. Use materials safely. (Rule #1 in Science: SAFETY FIRST) 3. Work cooperatively. 4. Pay close attention to the positioning of the magnets in relationship to each other. 5. It is easy to get your compass off balance when using magnets. Reposition as necessary. 6. All supplies will be returned at the end of the class period. |
| Questions | Questions for Student Exploration:  How can you make this compass move without touching it?  Can you make it spin?  What directions can you make it move?  How fast can you make it move?  Observable:  How many different ways can you make your device move without touching it?  Can you change the speed of the compass spinning?  Unobservable:  What force is acting on the device to make it move?  How do you know? What is your evidence?  **Teacher Tips:**  Let students know that during this activity it is quite easy to get the straw compass off balance and they will need to put it back carefully when that happens.  About 10-15 minutes into the exploration time, stop the class to see what ideas they have come up with to test in an experiment. Make sure they understand to only change on variable and keep the rest the same.  Ideas they may come up with may include but are not limited to: Using more flexible magnets, using other types of magnets, comparing forces of attraction to repulsion, etc.  They will notice that proximity as well as position of the magnet (with regard to pole orientation) play major roles in how fast a compass moves. |
| Summarize (10 minutes) | |
| Communicate | Whole Class Discussion:   * What did you learn when you tried to move the compass with the magnets? * What were the different strategies you tried that proved effective in moving your compass? * What forces were evident? How did you know. (Use the stem: I claim \_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.) * What did your experiment test? Report to the class (if time runs short, this part can be done another day.)   The goals is that students noted how they could use the force of attraction to move the compass in one direction by rotating a magnet. They also will have noticed they could do the same with attraction by rotating the magnet. Additionally, they may do the same for repelling magnets to cause movement. |
| Terminology and Concepts to Solidify | Vocabulary:   * repel—push away. * attract—pull forward. * poles- ends of a magnet. * magnetic field-space around a magnet.   Concepts:   * Magnets can attract or repel based on their orientation. * The north pole of one magnet attracts the south pole of a second magnet, while the north pole of one magnet repels the other magnet's north pole. * Like poles repel; opposite poles attract. * The magnetic force of a magnetic field is strongest at the poles. * Magnets can be used to make objects move via attraction. * Magnets can be used to make objects move via repulsion. * Magnets can be used to make objects move via a combination of attraction and repulsion. |
| Connection  to Big Ideas (Phenomena) | Anchoring Event  This activity may allow for connections to the initial video as the magnets will help make the compass move. It should be building on their understanding of how this unit works. |
| Follow Up/Practice | Share your results digitally via: Create a Graph  <http://nces.ed.gov/nceskids/createAgraph/> |
| Assessment | Design Your Experiment (Completed by Group)  Data Sheet (completed by each student) |
|  | Adapted from Building a Compass, Magnets and Motors, from Smithsonian/The National Academies National Science Resources Center |

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| Design Your Own Experiment |
| Our Question is: |
| What variable we will change: |
| What stays the same: |
| What additional equipment we will need: (if any) |
| What we will measure: |
| What we will observe: |
| Our hypothesis (what we think will happen): |

DATA TABLE

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| Our Question:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_? | | | |
| Predict: |  |  |  |
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| First Trial |  |  |  |
| Second Trial |  |  |  |
| Third Trial |  |  |  |

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In this activity, we observed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. This helps us explain \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.